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Multimodal Competence of Future Teachers – A Context of Understanding and Opportunities for Development in University Education

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Abstract: This article explores the formation and development of multimodal competence of preservice teachers in the context of teaching the disciplines Pedagogy of Construction and Technology Activities and Productive Activities in Technical and Technological Education in Kindergarten and in School 1st to 4th year classes. Students' multimodal competence is seen as a synergistic confluence of knowledge and skills related to different modes of communication - verbal, non-verbal, visual and digital. The focus is on the skills of selecting, combining, adapting and developing multimodal educational content, integration of communication channels and technological combination of different modalities in multimodal modes. The pilot study evaluated the feasibility of designing multimodal resources that respond to students' ages, levels of competence, learning styles, technological capabilities, and subject matter content, as well as creating learning environments that support students' cognitive, social, emotional, and personal development. The article emphasizes the need to integrate this knowledge into pedagogical practice, taking into account the ethical principles and value focuses that guide the design of multimodal environment. The results of the study show a significant improvement in students' skills in creating and adapting multimodal resources, and also highlight the importance of applying new technologies and artificial intelligence in the educational process in order to develop critical thinking, creative expression and personal growth in children and students.

Keywords: *multimodal competence, operationalization and development opportunities, multimodal technologies, multimodal resources, university teacher education.*

Introduction

In contemporary education, the multimodal competence of future teachers is essential as the educational process increasingly involves a combination of different communication modes - verbal, non-verbal, visual and digital. Children and learners perceive information in a variety of ways, and technology creates new opportunities for teaching that require teachers not only to be knowledgeable about different modalities, but also to have the skills to integrate them effectively.

In the academic literature, issues related to media and information literacy have been widely discussed in recent years, not only as a foundation for the application of digital technologies in education, but also in the context of teachers' educational needs (Makarova and Makarova, 2018; Stanišić, Leković and Stošić, 2019; Stosic, Dermendzhieva and Tomczyk, 2020; Simonović, 2021; Başaran, and Arık, 2022; Vesić, Laković and Vesić, 2023; Dašić, Ilievska Kostadinović, Vlajković and Pavlović, 2024). The authors categorically state that when we talk about raising the level of education, the most important thing is teacher education. In order to modernize the learning process, it is necessary to introduce modern media in the learning process (Novkovic Stošić and all, 2018: 1099).

In this context, an in-depth study of multimodal competence is necessary to understand how it can be incorporated into the university training of future teachers, as it is considered key to pedagogical effectiveness. This is because it enables the creation of adaptive and engaging educational resources

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tailored to the needs of diverse children and students (Georgieva, 2021). Teachers who are able to integrate different communication modes can create quality environments and designs in which educational content engages learners in a more accessible and motivating way, taking into account individual learning styles and technological capabilities. Moreover, multimodal competence helps to build critical thinking and reflexivity in future teachers, preparing them for the dynamic and digitalized environment in which they will be professionally realized.

The study of the level of development of multimodal competence is necessary not only because of technological changes, but also because of the social and ethical aspects of contemporary communication. Teachers should develop an awareness of the ways in which different modalities interact and their effects on the cognitive, social and emotional development of children and students. On the basis of such research, university education can offer targeted and systematic methodological variants for the development of the multimodal competence of students - future teachers, which will provide them with the necessary knowledge, skills and attitudes for successful professional activity and competitive advantage in an increasingly complex educational reality.

Theoretical Rationale

The theoretical propositions on multimodality as an analytic discourse represent a relatively new direction in the scientific search for the significance of this phenomenon for the understanding of communication. Conceptually, multimodality denotes the interaction between different communication modes - verbal, nonverbal, visual and auditory - which, in aggregate, shape the meaning of messages. It reveals the way in which semiotic resources combine and integrate in communicative processes, conditioning not only the transmission of information but also facilitating interpretation and understanding in different contexts. The functioning of different semiotic systems in oral, written, visual and digital communication events, as well as the unlimited possibilities of their combination, highlight multi-modality as a key mechanism of social interaction. It is the specific construct that ensures the flexibility and adaptability of communication, facilitating understanding between participants in different discursive practices. In this sense, multimodality does not simply complement communication, but significantly transforms it, expanding the boundaries of traditional communication and creating new possibilities for the expression and perception of content.

As a structurally defining element of communication, multimodality has existed since the dawn of human interactions, but its role is becoming more and more tangible with the dynamic development of information technology and the intensification of global data exchange. Although the phenomenon of multimodality has accompanied the development of civilization, it is the technological breakthroughs of the second half of the 20th century that have catalyzed scientific interest in it. The diversity of communication forms in digital and media environments makes multimodality an intersection point for various disciplinary fields that analyze its manifestations in the social, cultural, and cognitive structures of the contemporary world.

The distinction between pragmatic, compositional and hierarchical approaches to communication is becoming increasingly conventional as the boundaries between these analyses blur in multimodal discourse, where the interaction between different modes of communication plays a key role (O'Halloran, 2011). In contemporary communication, meaning is no longer formed solely through isolated structural or conceptual elements, but through their dynamic integration into a unified system that adapts to different contexts and modes of perception.

In multimodal text, the distribution of modal resources and the tensions between them form visual communication as a unified mechanism. This specificity allows in pedagogy interactions to simultaneously influence "spatial perception - the ability of an individual to detect how an object is oriented according to his or her own orientation and mental rotation - the ability of an individual to imagine both two-dimensional and three-dimensional objects and to rotate them in relation to the visual representation of the same object using only his or her mind" (Tasevska, 2023: 105). Whether perceived or created, multimodal design possesses a dynamic and multi-layered nature, for one modality may temporarily dominate but is unable to exclude the influence of others and/or ignore the contextual information they provide.

While multimodal interaction analysis focuses on the interaction between communicative elements, considering their density, integrity, and their relationship to contextual information and aesthetic organization (Scollon and Scollon, 2003; Norris, 2020), as noted in previous research, critical multimodal textual

analysis within semiotics focuses not so much on the structure of communicative resources themselves, but on their social and pragmatic role in the system of codes and meanings. This distinction is particularly relevant in the context of multi-modal competence because it emphasizes the importance of not only the formal but also the functional side of communication. Future teacher education needs to focus on understanding how, through different communication modes (verbal, visual, auditory, etc.), interactants shape the context in which they are perceived. Teachers must not only be experts at discerning different semiotic resources, but also be able to anticipate and interpret how these resources relate to the cultural, social, and individual contexts of children and students. The interaction of these elements in the environment requires teachers to be aware and flexible in order to adapt their communication according to the dynamics of the situation and the needs of the children and students. When we talk about multimodal competence, it is important to bear in mind that in social and pedagogical practice not only one or two communication channels are used.

In the multimodal approach, each resource has a unique role in expressing, specifying and making sense of meanings. Here, the "chronological determinacy of cognitive algorithms as a system of codes of the socialization process" (Dyankova, 2019: 59) is taken into account, which unequivocally affirms that "there is not and cannot be a social life if it is not lived through consciousnesses that are in relations with each other" (Tasevska, Yonkova, Boradzhieva, 2015: 8). For example, when using visual and audio-visual elements, the teacher can create a more effective and engaging educational process by integrating diverse communication channels that not only support but also enhance the understanding of the educational content. In this context, it is important for teachers to be able to manage and combine different modes, taking into account the specific needs of students and the social context of learning.

Critical multimodal analysis within semiotics also highlights how social and cultural factors influence the perception of different communication elements. That is, multimodal competence requires teachers to understand how different social groups perceive communication and how different cultures may interpret visual and verbal messages differently. This dynamic between expressive media and social contexts is crucial for successful teaching because it allows teachers to create inclusive and ethically sound educational practices that take into account students' diversity and stimulate their interest and participation in the learning process.

Previous research (Dermendzhieva and Tsankov, 2023) has focused on the formation of pedagogical competence to design multimodal educational environments that stimulate the cognitive and creative activity of preschool children. A major emphasis is placed on the need for professional reflection of the children's teacher, who must work in the context of a transgressive approach. This approach involves the integration of different forms of communication and is important for the development of skills and knowledge that equip teachers to design effective learning environments. One of the main ideas is that a child teacher's competence in designing multimodal environments is formed and developed in the process of continually cultivating new knowledge and skills. This involves expanding the teacher's cognitive and practical boundaries, which creates opportunities for better understanding and inclusion of the child in dynamic educational processes. In this context, multi-modality, as a phenomenon of communication, is perceived as an essential resource that allows a variety of interactions that activate children's cognitive and creative potential. It is theorized that when children engage in multimodal educational interactions, they not only learn social experiences but also form a transgressive attitude that influences their behavioral response. This, coupled with children's multifaceted expression, the multilayered sign language, the dynamic connectivity of information media, and dialogic communication with the child, creates a complex learning environment. This environment aims at developing the visual, informational, multicultural, media and digital experiences of preschool children, helping their holistic development in the modern world. In the context of forming a holistic learning environment in kindergarten and school, multimodality plays an essential role through authenticity, dynamism and multidimensionality. It overcomes the schematicism and linearity of thinking by activating the imagination and stimulating the creative and cognitive activity of children and students. Multimodality not only enriches social interactions, but is fundamental to the development of cognitive and affective capacities that lead to deeper self-awareness and personal growth. The possibility of integrating different communication modalities in the educational environment ensures greater student engagement and increases the effectiveness of pedagogical interactions.

Previous research by the authors (Tsankov and Dermendzhieva, 2024) examined methods for evaluating multimodal digital resources developed by students who would become child-care and school teachers. The evaluation of these resources is based on principles such as autonomy, coherence,

groundedness and authenticity, with the ability to enrich the individual sensory experience of children and students and to provoke their cognitive and personal activity being key indicators of their successful application. These criteria create conditions for building resources that can enrich pedagogical interaction by stimulating creative and non-linear thinking, both at an early age and during schooling.

The design of multimodal digital resources for the purpose of environmental composition in kindergarten and school offers the possibility of creating dynamic and engaging environments that combine cognitive, affective and sensory experiences. This combination supports children's and students' development and self-awareness, while encouraging personal expression. Research highlights the importance of appropriate education for future child teachers and teachers in different types of schools, who need to have the skills to design multimodal digital resources. This creates dynamic and effective learning environments that overcome imbalances between sociocultural and individual differences and optimise the development of children and students.

The multimodal competence of future teachers is crucial for understanding and effectively using the various communicative modes that construct meaning in the educational process. The design of multimodal content does not simply convey information, but selects and structures meaning by combining visual, verbal, and other means of expression to create an overall message. In this context, multimodal communication extends the boundaries of traditional discourse, allowing for multiple layers of meaning, personalization of ideas, and dynamic adaptation to cultural and social conditions. Understanding these processes requires a specific research approach and toolkit to support teachers in designing educational resources that integrate different communication modes for more effective learning and interaction.

Materials and Methods

Within the pilot study, the multimodal competence of the students - future teachers - is viewed as a synergistic confluence of: knowledge of different modes of communication - verbal, non-verbal, visual and digital skills: (1) to select, combine, adapt and develop multimodal educational content, (2) to integrate different communication channels, (3) to technologically combine different modalities in multimodal modes, (4) to design multimodal resources according to the subjects (age characteristics, levels of competence, learning styles), technological capabilities, subject content, expected outcomes, and cross-curricular specifics, (5) designing multimodal resources while adhering to ethical principles and value-based focuses, (6) designing multimodal environments for cognitive, social, psychological, physical, emotional, and personal development and opportunities for subject expressions; attitudes and dispositions toward: (1) mode of interaction, interpenetration and complementarity of different modalities and the dynamics and interrelationships in communication, (2) personalization of the integration of communicative modes in multimodal communication settings.

The developed and approbated technology of forming multimodal competence for students - future teachers - consists of several main stages, which cover both theoretical and practical knowledge and skills. Functionally, the implemented technology is effective in two directions:

1. Regarding the quality of academic training for the students who are future pedagogical specialists: "The integration of digital writing tools into academic programs, combined with strategies to promote student engagement, can lead to improved self-efficacy and ultimately better academic performance" (Bekturova, M., A. Zhaitapova, D. Gaipov, S. Tulepova, G. Dyankova, 2024: 616).
2. Concerning the professional-pedagogical perspective of students - future pedagogical specialists, "it is the teacher 5.0 who will have to shift education from its technological focus and saturate it with more opportunities for the development of students' socio-emotional competence, which will prove to be the key to Economy 5.0 (Mihova, 2023: 20).

Therefore, initially, students are given a basic understanding of the different modes of communication, such as verbal, non-verbal, visual and digital, focusing on their role in the educational process. This knowledge forms the basis for building competence in creating effective multimodal educational resources. Then, the focus is more on the development of skills to combine, adapt and develop multimodal educational content. Students are taught how to integrate different communication channels and technologically combine different modalities into multimodal ensembles. They are also introduced to the principles of designing multimodal resources to meet students' age, competency levels, and learning

styles, as well as to match subject content and cross-curricular specifics. Technology succeeds in preparing students to design multimodal environments that not only support children/students' cognitive and social progress, but also stimulate their emotional and personal development. It is important for students to learn how to create multimodal resources that adhere to ethical principles and value-based focuses while also strengthening relationships and interactions between different communication modalities. The goal is to develop competence for dynamic and innovative pedagogical interaction, which will support the development of children/students in a multimodal educational environment.

The technology for the formation of multimodal competence is successfully integrated into the academic disciplines "Pedagogy of construction and technology activities" and "Productive activities in technical and technological education in kindergarten and 1-4 grade", which significantly enriches the learning process and develops key skills in students – future teachers. In these courses, which are aimed at developing teachers' practical skills for working with children in the early stages of education, technology is implemented through the application of a greater knowledge of different communication modes - verbal, non-verbal, visual and digital. Thus, students master the skills of matching and adapting multimodal resources according to the age characteristics and technological capabilities of children and students.

As a result of the application of this technology, students actively learn methods of integrating different communication channels and technologies that are in sync with the pedagogical goals of the disciplines. Throughout the learning process, they design multimodal resources that foster creativity, the building of constructivist and technological skills, and the development of children's cognitive abilities. In each of these disciplines, multimodal competence is seen as the basis for creating learning environments that stimulate children's active participation and expression while meeting their specific needs and levels of competence.

Through the formation and development of multimodal competence in these disciplines, future teachers are able to develop and implement educational resources that are not only technologically innovative but also pedagogically effective. The technology for multimodal design in the disciplines "Pedagogy of Construction and Technology Activities" and "Productive Activities in Technical and Technological Training" creates dynamic educational spaces that enrich children's sensory, cognitive, and emotional experiences. In this way, students acquire the necessary skills to create integrated educational environments that not only align with pedagogical goals but also offer opportunities for both individual and collective expression. This approach fosters children's and students' creative and technological engagement, encouraging active participation and innovation in the learning process.

Results

As part of the pilot study, two groups were formed: 60 undergraduate students (full-time study) and 90 master's students (part-time study). Initially, it was examined whether the distribution of the primary test data at the diagnostic stage of the study was normal or not, in order to determine which statistical methods (parametric or non-parametric) should be used. The Shapiro-Wilk test was applied for this purpose. The statistical hypotheses tested were: H_0 – the data follow a normal distribution, and H_1 – the data do not follow a normal distribution. The empirical data were subjected to statistical analysis, the results of which are shown in the following Table No.1.

Table 1. *Distribution test results (Test of Normality)*

Group	Shapiro-Wilk		
	Shapiro-Wilk Statistic	**df** Degrees of Freedom	**Sig. (p-value)** The p-value indicating whether the data significantly deviate from a normal
Bachelor's (full-time study)	.918	60	.012
Master's (part-time study)	.876	90	.027

In the Test of Normality table, the statistical significance Sig. represents the p-value used to test the null hypothesis (H_0) that the data follow a normal distribution. For the first group of students (Bachelor's, full-time study), the p-value (Sig.) is 0.012, which is less than 0.05. This indicates a statistically significant deviation from normality, meaning that the data for bachelor's students (full-time study) do not follow a normal distribution. For the second group of students (Master's, part-time study), the p-value (Sig.) is

0.027, which is also less than 0.05. This again suggests a statistically significant deviation from normality. As a result, the null hypothesis (H_0) is rejected, confirming that the data for master's students (part-time study) are also not normally distributed.

The Shapiro-Wilk test for each study group is statistically significant, i.e. p(Sig.)<0.05, which is a reason to accept the alternative hypothesis that the data studied do not have a normal distribution and the use of non-parametric methods of analysis is justified.

The established differences in the criteria "knowledge" and "skills" in the final study in the groups after the application of the technological variant based on the constructivist and situational approach to the development of multimodal competence of students in the conditions of constructivist educational environment are presented in Table 2.

The statistical interpretation of the data in terms of the degree of formation and development of multimodal competence based on the transgressive synergetic model of competence development and operationalized technological variant in the subject field of the academic disciplines "Pedagogy of construction and technology activities" and "Productive activities in technical and technological training in kindergarten and grades 1-4" is presented summarized and commented indicatively in view of the objectives of the specific empirical study. In the context of the pilot study, the focus is on the degree of formation of skills as basic constructs of multimodal competence, as well as the possibility of their development through the applied technological option.

When comparing the differences in the groups (B.Sc. and M.Sc.) in terms of K_x, a certain difference in favour of the M.Sc. students was found.

When comparing the results at the beginning and at the end of the study, Wilcoxon test (Wicoxon) was again used to compare two correlated (related) samples (groups), and the decision was based on the significance level (α), which corresponds to the empirical value of the criterion.

Table 2. *Average coefficients - degree of development by criteria*

Criterion	Average Coefficient – Development Level (K_x) Bachelor's			Average Coefficient – Development Level (K_x) Master's		
	Initial Study	Final Study	Difference (development level)	Initial Study	Final Study	Difference (development level)
Knowledge of different communication modes	0,24	0,52	0,28	0,29	0,63	0,34
Selection, combination, adaptation, and development of multimodal educational content	0,31	0,64	0,33	0,35	0,72	0,37
Integration of different communication channels	0,22	0,58	0,36	0,28	0,65	0,37
Technological combination of different modalities in multimodal modes	0,30	0,52	0,22	0,45	0,85	0,40
Design of multimodal resources according to:	0,21	0,53	0,32	0,32	0,69	0,37
Subjects	0,20	0,45	0,25	0,22	0,52	0,30
Technological possibilities	0,18	0,40	0,22	0,42	0,86	0,44
Subject content	0,30	0,70	0,40	0,35	0,80	0,45
Expected results	0,25	0,75	0,50	0,40	0,85	0,45
Interdisciplinary specifics	0,12	0,35	0,23	0,20	0,42	0,22
Design of multimodal resources while adhering to ethical principles and value focuses	0,36	0,66	0,30	0,42	0,80	0,38
Design of multimodal environments	0,18	0,68	0,50	0,22	0,86	0,64

The results of the application of the Wilcoxon test (Wicoxon) show the associated significance level, given in the order Asymp. Sig. (2-tailed), with respect to the B.Sc. p=0.045<0.05 and with respect

to the M.Sc. p=0.017<0.05, in both cases it is the basis for the conclusion that the difference between the two scores at the beginning and end of the application of the research program, i.e. The difference between the results at the beginning and the end of the study is statistically significant, which is the basis for accepting the alternative hypothesis, according to which the differences observed in the empirical data are the result of regular factors, i.e. the outcome of the applied technological option for the development of multimodal competence of students - future teachers.

Discussions

The results of the statistical interpretation of the data show clear evidence of the effectiveness of the applied technology for the formation and development of students' multimodal competence in the context of the definition of this competence as a synergistic set of knowledge and skills. In the study, the focus is on the acquisition of different modes of communication - verbal, non-verbal, visual and digital, and the possibility of integrating and combining these communication channels in multimodal modes. Evidence of the effectiveness of the approach is obtained through the significant advances in students' skills in selecting, adapting, and developing multimodal educational content, as well as in the technological combination of different modalities in view of the specific needs of learners and the conditions of the educational environment.

Essential to the development of multimodal competence is not only the ability to combine different communication channels, but also to design multimodal resources in accordance with children's age characteristics, technological capabilities and the specifics of the learning content. This includes expanding the competence of preservice teachers to design instructional resources to meet different learning styles and different educational and ethical demands. It has been shown that students who go through this technological option of training also develop attitudes of ethicality in the creation of multi-modal educational materials and to ensure inclusiveness in the educational process, in line with the values and principles of modern education.

The research findings also show that the integration of different communication modes in the context of multimodal communication leads to the development of a dynamic interaction between these modes, each of them contributing to the possibility of a deeper perception of educational content. Students demonstrate an increasing ability to design multimodal environments that not only stimulate the cognitive and social development of children and students, but also provide opportunities for emotional, psychological, and personal development. This creates the conditions for the development of a synergistic process in which the different modalities interact and mutually enrich each other, and this integration not only improves the effectiveness of learning, but also provides a more complete and realistic opportunity for the formation of competence oriented to the modern multimodal world.

In order to improve the application of technology for the development of multimodal competence of future teachers, it is necessary to strengthen the integration of the practical application of multimodal approaches in the context of different disciplines. This can be achieved through the creation of cross-curricular projects and interactive learning scenarios that bring together knowledge and skills from different areas of learning, such as pedagogy, technology and digital communication. Through the implementation of such projects, students will have the opportunity to work with a variety of multimodal resources and develop greater flexibility in their application according to the context and needs of the learners.

In addition, in order to achieve a deeper development of the skills of designing and integrating multimodal resources, it is necessary to introduce specific methods of reflection and self-evaluation in the learning process. Students can be engaged in creating portfolios that include their multimodal projects as well as detailed analyses of the approaches used in them. Through such reflection, they will have the opportunity not only to evaluate the results of their work, but also to become aware of how different communication channels can be combined and adapted according to the requirements of the specific educational situation.

Finally, in order to improve the ethical aspect of multimodal technology implementation, it is important to strengthen learning initiatives that promote awareness of the ethical and social implications of using digital technologies in education. This includes the development of courses and workshops focused on issues of copyright, digital security and inclusivity in the educational process. Students must be prepared to create multimodal resources that are not only technologically sophisticated, but also aligned with ethical standards and values that ensure equitable access to knowledge and learning for all children and students.

The creation of multimodal resources enriches the educational process by integrating different

forms of communication - text, images, video, sound and interactive elements, which stimulates different channels of perception and learning. Artificial intelligence (AI) provides significant opportunities to adapt these resources to the individual needs of children and students, automating the processes of creating and personalising learning content. AI can analyze children/students' progress and generate dynamic and personalized learning experiences that change depending on their development and learning style. Despite these capabilities, there is a need for a concerted effort to build the skills to use AI effectively in the educational process. This includes both developing the technical competence to work with new technologies, and promoting critical thinking, ethical attitudes and responsibility in the use of AI in learning to ensure equal access and maximum benefits for all children and students, in the context not only of the classroom but also of the wider educational process.

Conclusions

The overall research focuses on the formation and development of multimodal competence in future teachers, applying a synergistic approach combining different modes of communication - verbal, non-verbal, visual and digital. Through a pilot study in the context of the educational disciplines "Pedagogy of Construction and Technology Activities" and "Productive Activities in Technical and Technological Education in Kindergarten and Grades 1-4", the possibility of developing these competencies through specialized technologies is explored. The focus is on the skills of creating, adapting and integrating multimodal resources as core components of competence, which include both technological and pedagogical skills for personalizing the educational process.

The results of the study show a statistically significant improvement in the skills of creating and integrating multimodal resources among students, which is confirmed through a comparative analysis of data before and after the implementation of the research methodology. The use of statistical tools, such as Wilcoxon's Test, demonstrates the success of the proposed technology for the development of multimodal competence, confirmed by the positive changes in both undergraduate and graduate students. This supports the thesis that the application of the transgressive synergistic model in education can effectively develop key skills needed to create innovative and dynamic educational resources.

Despite the results, the study highlights the need for focused efforts to continue to build skills in working with new technologies, including artificial intelligence. In order to maximise the benefits of these technologies, it is important that teachers are equipped to use them ethically and responsibly, while developing the skills to think critically and apply innovation to the educational process.

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Conflict of interests

The authors declare no conflict of interest.

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